

We claim:

1 1. A method for chemical mechanical polishing of tungsten comprising:
2 providing a semiconductor substrate comprising on one face tungsten and a dielectric
3 material;
4 providing a chemical mechanical polishing composition comprising between about 2%
5 and about 15% ammonium persulfate, between about 0.1% and about 10 % of a secondary
6 oxidizer, a pH adjusting compound to adjust the pH of the composition, and optionally an
7 abrasive, wherein the pH of the composition is between about 6.5 to about 12;
8 movably contacting the substrate face with a pad exerting between about 0.1 and about 9
9 psi pressure on the substrate and with the composition under conditions that tungsten is removed
10 at a rate different than the removal of the dielectric material.

1 2. The process of claim 1 wherein the secondary oxidizer comprises potassium
2 peroxymonosulfate, peroxymonosulfuric acid, imidazole, malonic acid, or malonamide.

1 3. The process of claim 1 wherein the chemical mechanical polishing composition
2 comprises at least one of potassium iodate, potassium periodate, or lithium periodate.

1 4. The process of claim 1, wherein the chemical mechanical composition comprises
2 periodic acid, peracetic acid, oxalic acid, citric acid, lactic acid, NH_4HF_2 , or a mixture thereof.

1 5. The process of claim 1 wherein the secondary oxidizer comprises hydrogen
2 peroxide, a perborate, a peroxyhydrate, or a urea hydrogen peroxide complex.

1 6. The process of claim 1 wherein the chemical mechanical polishing composition
2 additionally comprises an organic acid selected from the group consisting of gluconic, malonic
3 acid, lactic acid, succinic acid, tartaric acid, citric acid, oxalic acid, or salts thereof.

1 7. The process of claim 1 further comprising a second polishing operation
2 comprising the steps of:

3 providing a second chemical mechanical polishing composition comprising an oxidizer, a
4 pH adjusting compound to adjust the pH of the composition, and optionally an abrasive, wherein
5 the pH of the composition is between about 3 to about 12;

6 movably contacting the substrate face with a pad exerting between about 0.1 and about 9
7 psi pressure on the substrate and with the second composition under conditions that tungsten is
8 removed at a rate different than the removal of the dielectric material.

1 8. The process of claim 7 wherein the second chemical mechanical polishing
2 composition comprises ammonium persulfate, a pH adjusting compound to adjust the pH of the
3 composition, and optionally an abrasive, wherein the pH of the composition is between about 3
4 to about 12.

1 9. A method for chemical mechanical polishing of tungsten comprising:
2 providing a semiconductor substrate comprising on one face tungsten and a dielectric
3 material;

4 providing a chemical mechanical polishing composition comprising between about 0.5%
5 and about 10% periodic acid, between about 0.1% and about 10 % of a secondary oxidizer, a pH
6 adjusting compound to adjust the pH of the composition, and optionally an abrasive, wherein the
7 pH of the composition is between about 4 to about 12;

8 movably contacting the substrate face with a pad exerting between about 0.1 and about 9
9 psi pressure on the substrate and with the composition under conditions that tungsten is removed
10 at a rate different than the removal of the dielectric material.

1 10. The process of claim 9 wherein the secondary oxidizer comprises potassium
2 peroxymonosulfate, imidazole, malonic acid, or malonamide.

1 11. The process of claim 9 wherein the chemical mechanical polishing composition

2 comprises at least one of potassium iodate, potassium periodate, or lithium periodate.

1 12. The process of claim 9 wherein the chemical mechanical composition comprises
2 ammonium persulfate, peracetic acid, oxalic acid, NH₄HF₂, or a mixture thereof.

1 13. The process of claim 9 wherein the secondary oxidizer comprises hydrogen
2 peroxide, a perborate, a peroxhydrate, or a urea hydrogen peroxide complex.

1 14. The process of claim 9 wherein the chemical mechanical polishing composition
2 additionally comprises an organic acid selected from the group consisting of gluconic, malonic
3 acid, lactic acid, succinic acid, tartaric acid, citric acid, oxalic acid, or salts thereof.

1 15. The process of claim 9 further comprising a second polishing operation
2 comprising the steps of:

3 providing a second chemical mechanical polishing composition comprising an oxidizer, a
4 pH adjusting compound to adjust the pH of the composition, and optionally an abrasive, wherein
5 the pH of the composition is between about 3 to about 12;

6 movably contacting the substrate face with a pad exerting between about 0.1 and about 9
7 psi pressure on the substrate and with the second composition under conditions that tungsten is
8 removed at a rate different than the removal of the dielectric material.

1 16. The process of claim 9 wherein the second chemical mechanical polishing
2 composition comprises 0.5% and about 10% periodic acid, a pH adjusting compound to adjust
3 the pH of the composition, and optionally an abrasive, wherein the pH of the composition is
4 between about 3 to about 12.

1 17. A method for chemical mechanical polishing of copper comprising:
2 providing a semiconductor substrate comprising on one face copper and a dielectric
3 material;

4 providing a chemical mechanical polishing composition comprising between about 1%
5 and about 20% hydroxylamine, hydroxylamine sulfate, hydroxylamine nitrate, or mixture thereof,
6 between about 0.1% and about 10 % of a carboxylic acid, a pH adjusting compound to adjust the
7 pH of the composition, and optionally an abrasive, wherein the pH of the composition is between
8 about 3 to about 12;

9 movably contacting the substrate face with a pad exerting between about 0.1 and about 9
10 psi pressure on the substrate and with the composition under conditions that copper is removed at
11 a rate different than the removal of the dielectric material.

1 18. The process of claim 17 wherein the chemical mechanical polishing composition
2 comprises potassium peroxyomonosulfate, imidazole, malonic acid, or malonamide, and wherein
3 the second material is a dielectric material.


1 19. The process of claim 17 wherein the chemical mechanical polishing composition
2 comprises at least one of potassium iodate, potassium periodate, or lithium periodate.

1 20. The process of claim 17 wherein the chemical mechanical composition comprises
2 periodic acid, peracetic acid, oxalic acid, NH_4HF_2 , or a mixture thereof.

1 21. The process of claim 17 wherein the secondary oxidizer comprises hydrogen
2 peroxide, a perborate, a peroxhydrate, or a urea hydrogen peroxide complex.

1 22. The process of claim 17 wherein the chemical mechanical polishing composition
2 additionally comprises an organic acid selected from the group consisting of gluconic, malonic
3 acid, lactic acid, succinic acid, tartaric acid, citric acid, oxalic acid, or salts thereof.

1 23. The process of claim 17 further comprising a second polishing operation
2 comprising the steps of:
3 providing a second chemical mechanical polishing composition comprising an oxidizer, a

4 pH adjusting compound to adjust the pH of the composition, and optionally an abrasive, wherein
5 the pH of the composition is between about 3 to about 12;

6 movably contacting the substrate face with a pad exerting between about 0.1 and about 9
7 psi pressure on the substrate and with the second composition under conditions that copper is
8 removed at a rate different than the removal of the dielectric material.

1 24. The process of claim 17 wherein the second chemical mechanical polishing
2 composition comprises hydroxylamine or a salt thereof, a pH adjusting compound to adjust the
3 pH of the composition, and optionally an abrasive, wherein the pH of the composition is between
4 about 3 to about 12.

1 25. A method for chemical mechanical polishing of aluminum comprising:
2 providing a semiconductor substrate comprising on one face aluminum and a dielectric
3 material;

4 providing a chemical mechanical polishing composition comprising between about 2%
5 and about 12% ammonium persulfate, a pH adjusting compound to adjust the pH of the
6 composition, and optionally an abrasive, wherein the pH of the composition is between about 2
7 to about 8;

8 movably contacting the substrate face with a pad exerting between about 0.1 and about 9
9 psi pressure on the substrate and with the composition under conditions that aluminum is
10 removed at a rate different than the removal of the dielectric material.

1 26. The process of claim 25 wherein the chemical mechanical polishing composition
2 comprises potassium peroxyomonosulfate, peroxyomonosulfuric acid, imidazole, malonic acid, or
3 mixture thereof.

1 27. The process of claim 25 wherein the chemical mechanical polishing composition
2 comprises at least one of potassium iodate, potassium periodate, or lithium periodate.

1 28. The process of claim 25, wherein the chemical mechanical composition comprises
2 periodic acid, peracetic acid, oxalic acid, citric acid, lactic acid, NH₄HF₂, or a mixture thereof.

1 29. The process of claim 25 wherein the chemical mechanical polishing composition
2 comprises hydrogen peroxide, a perborate, a peroxyhydrate, or a urea hydrogen peroxide complex.

1 30. The process of claim 25 wherein the chemical mechanical polishing composition
2 additionally comprises an organic acid selected from the group consisting of gluconic, malonic
3 acid, lactic acid, succinic acid, tartaric acid, citric acid, oxalic acid, or salts thereof.

1 31. The process of claim 25 further comprising a second polishing operation
2 comprising the steps of:

3 providing a second chemical mechanical polishing composition comprising an oxidizer, a
4 pH adjusting compound to adjust the pH of the composition, and optionally an abrasive, wherein
5 the pH of the composition is between about 3 to about 12;

6 movably contacting the substrate face with a pad exerting between about 0.1 and about 9
7 psi pressure on the substrate and with the second composition under conditions that alumina is
8 removed at a rate different than the removal of the dielectric material.

1 32. The process of claim 25 wherein the second chemical mechanical polishing
2 composition comprises ammonium persulfate, a pH adjusting compound to adjust the pH of the
3 composition, and optionally an abrasive, wherein the pH of the composition is between about 3
4 to about 12.

1 33. A method for chemical mechanical polishing of a substrate comprising:
2 providing a semiconductor substrate comprising on one face a metal and a dielectric
3 material;

4 providing a chemical mechanical polishing composition comprising between about 0.1%
5 and about 10% of ammonium hydroxide, NH₄HF₂, peracetic acid, or mixture thereof, a pH

6 adjusting compound to adjust the pH of the composition, and optionally an abrasive, wherein the
7 pH of the composition is between about 2 to about 13;

8 movably contacting the substrate face with a pad exerting between about 0.1 and about 9
9 psi pressure on the substrate and with the composition under conditions that metal is removed at
10 a rate different than the removal of the dielectric material.

1 34. The process of claim 33 wherein the chemical mechanical polishing composition
2 comprises potassium peroxyomonosulfate, peroxyomonosulfuric acid, imidazole, malonic acid, or
3 malonamide.

1 35. The process of claim 33 wherein the chemical mechanical polishing composition
2 comprises at least one of potassium iodate, potassium periodate, or lithium periodate.

1 36. The process of claim 33, wherein the chemical mechanical composition comprises
2 periodic acid, peracetic acid, oxalic acid, citric acid, lactic acid, or a mixture thereof.

1 37. The process of claim 33 wherein the chemical mechanical polishing composition
2 comprises hydrogen peroxide, a perborate, a peroxyhydrate, or a urea hydrogen peroxide complex.

1 38. The process of claim 33 wherein the chemical mechanical polishing composition
2 additionally comprises an organic acid selected from the group consisting of gluconic, malonic
3 acid, lactic acid, succinic acid, tartaric acid, citric acid, oxalic acid, or salts thereof.

1 39. The process of claim 33 further comprising a second polishing operation
2 comprising the steps of:

3 providing a second chemical mechanical polishing composition comprising an oxidizer, a
4 pH adjusting compound to adjust the pH of the composition, and optionally an abrasive, wherein
5 the pH of the composition is between about 3 to about 12;

6 movably contacting the substrate face with a pad exerting between about 0.1 and about 9

7 psi pressure on the substrate and with the second composition under conditions that the metal is
8 removed at a rate different than the removal of the dielectric material.

1 40. A method for chemical mechanical polishing of copper comprising:
2 providing a semiconductor substrate comprising on one face copper and a dielectric
3 material;

4 providing a chemical mechanical polishing composition comprising between about 0.1%
5 and about 10% ammonium persulfate, at least one of a secondary oxidizer, an organic acid, or a
6 chelating agent, a pH adjusting compound to adjust the pH of the composition, and optionally an
7 abrasive, wherein the pH of the composition is between about 3 to about 8;

8 movably contacting the substrate face with a pad exerting between about 0.1 and about 9
9 psi pressure on the tungsten substrate and with the composition under conditions that tungsten is
10 removed at a rate different than the removal of the dielectric material.

1 41. The process of claim 40 wherein the secondary oxidizer comprises potassium
2 peroxymonosulfate, imidazole, malonic acid, potassium iodate, potassium periodate, lithium
3 periodate, or malonamide, periodic acid, oxalic acid, and wherein the second material is a
4 dielectric material.

1 42. The process of claim 41 wherein the chemical mechanical polishing composition
2 additionally comprises an organic acid selected from the group consisting of gluconic, malonic
3 acid, lactic acid, succinic acid, tartaric acid, citric acid, or salts thereof.

1 43. A method for chemical mechanical polishing of tungsten comprising:
2 providing a semiconductor substrate comprising on one face tungsten and a dielectric
3 material;
4 providing a chemical mechanical polishing composition comprising between about 2%
5 and about 20% hydroxylamine, between about 0.1% and about 10 % of a secondary oxidizer, a
6 pH adjusting compound to adjust the pH of the composition, and optionally an abrasive, wherein

7 the pH of the composition is between about 7 to about 12;
8 movably contacting the substrate face with a pad exerting between about 0.1 and about 9
9 psi pressure on the substrate and with the composition under conditions that tungsten is removed
10 at a rate different than the removal of the dielectric material.

1 44. The process of claim 43 wherein the secondary oxidizer comprises potassium
2 peroxymonosulfate, peroxyomonosulfuric acid, imidazole, malonic acid, or malonamide.

1 45. The process of claim 43 wherein the chemical mechanical polishing composition
2 comprises at least one of potassium iodate, periodic acid, peracetic acid, potassium periodate,
3 NH₄HF₂, or lithium periodate.

1 46. The process of claim 43 wherein the secondary oxidizer comprises hydrogen
2 peroxide, a perborate, a peroxhydrate, or a urea hydrogen peroxide complex.

1 47. The process of claim 43 wherein the chemical mechanical polishing composition
2 additionally comprises an organic acid selected from the group consisting of gluconic, malonic
3 acid, lactic acid, succinic acid, tartaric acid, citric acid, oxalic acid, citric acid, or salts thereof.